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PROBLEM IN HIGHWAY ENGINEERING

By PROF. ARTHUR H. BLANCHARD
In charge of Highway Engineering and Highway Transport at the University of Michigan

Highways are merely the means to an end: that end is primarily economic and efficient transportation of passengers and commodities. Unfortunately, this fundamental principle has not been the general basis for the improvement of state, county and town highways. Of the 2,500,000 miles of highways outside of municipalities in the United States, only twelve per cent can be classified as improved and not over one-fourth of one per cent are suitable to carry intensive motor truck traffic.

Today the highway engineer is giving sober consideration to the several phases of the intimate relationship between efficient highway design and economic motor transport. He is endeavoring to look at the problems associated with the transportation of commodities and passengers over highways. One important phase of motor transport, in which the highway engineer should be interested is the relation of highways to motor truck operating cost. In order to determine this relationship it is evident that a thorough field investigation of every proposed highway transport route should be made. The results of this survey would be roughly classified under the following three heads:

1. Relation of unimproved highways to operating cost.

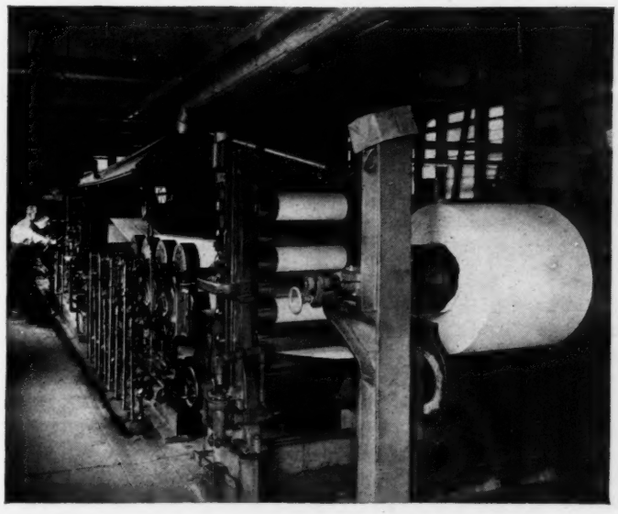
2. Relation of proposed new construction and reconstruction of improved sections to operating cost.

3. Relation of sections of improved highways which will not be reconstructed for a period of five years to operating cost

As a basis for the discussion of the relation of highways to the several component parts of operating cost, there is given below an analysis of the 1919 average daily cost of operating a five-ton truck for an average of fifty miles per day over improved highways for three hundred days per year. This analysis was compiled by George H. Pride, President of The Heavy Haulage Company of New York City.

Driver	$5.00
Tires, guaranteed basis	3.00
Oil, grease, etc.	.50

(*Continued on page 16*)



PAPER MILL AT THE BUREAU OF STANDARDS
The Bureau has adequate equipment to determine the commercial practicability of many industrial processes and operations.

A GREAT LAKES TIDEWATER CANAL

By H. C. GARDNER
President of the Great Lakes-St. Lawrence Tidewater Association

Perhaps the greatest piece of engineering work in the world now under active consideration is the improvement of the St. Lawrence River so that ocean-going ships may enter the Great Lakes, with the incidental development of electric power. The United States and Canada have the matter under investigation, and it is believed that a report will be made to Congress this winter.

The question of better transportation facilities and conditions is recognized as vital. The conducting of transportation is in a true sense engineering, although not generally so recognized.

The great engineering problems in connection with the St. Lawrence development would be:

(*Continued on page 19*)

THE NATIONAL BUREAU OF STANDARDS

H. G. BOUTELL
Of the Bureau of Standards, Washington, D. C.

In order to understand readily the character of the work of the Bureau of Standards, it is necessary to have an idea of the different kinds of standards with which it deals and also of the Bureau's organization as regards its scientific staff. Standards of measurements, such as those of length, mass, and time, are familiar to every one. Besides these, there are standard constants, such as the mechanical equivalent of heat; standards of quality, as represented by specifications; standards of performance, such as those used in determining the rating of engines, motors, and other appliances, and standards of practice, under which may be included the formulation of industrial and safety codes.

The work of the engineer is concerned with all of these standards, and he depends on their accurate determination for the successful carrying on of his work. The Bureau's organization is based on the character of the services to be performed by its employees and not upon the kinds of standards, as this has been found more convenient and results in a better grouping of the experts in the different lines.

There are nine scientific divisions: electrical; weights and measures; heat and thermometry; optical; chemistry; engineering physics; structural, engineering and miscellaneous materials; metallurgy, and ceramics. All of these divisions are housed in specially designed laboratory buildings located on the outskirts of Washington, where conditions are particularly favorable for accurate scientific work.

Organized as described in the above paragraph, any problem dealing with electricity, whether in connection with the determination of a fundamental constant or in the rating of an electric motor, or in the life test of an incandescent lamp, is referred to the electrical division. The same may be said of the other scientific divisions. The duties performed by each of the various divisions may be briefly described as follows:

The electrical division, as has already been mentioned, is concerned with all

(*Continued on page 6*)

THE WORK OF THE MIAMI CONSERVANCY DISTRICT

By GERARD H. MATTHES, '95
Of the Miami Conservancy District

During the great flood of March 1913, the volume of water which passed through Dayton, Ohio, amounted to 250,000 cubic feet per second. As the Miami River channel had then a capacity of only 90,000 cubic feet per second, wide spread inundation resulted. This discrepancy between flood flow and channel capacity is typical of the conditions which existed at all of the principal towns in the Miami Valley, and this is the more significant since in the towns the carrying capacity of the channel had been appreciably improved by means of levees. Outside the towns the natural river channel possessed a capacity only one-tenth of the maximum 1913 flood discharge.

The damage in 1913, throughout the valley, has been placed at $100,000,000, but there is reason to believe that this figure is small. The damage was of a far reaching nature and difficult to evaluate. Over 360 lives were lost and about 30 cases of insanity resulted.

Immediately after the flood mass meetings were held to devise plans for protecting against future high waters. In Dayton, under the leadership of public spirited citizens, $2,000,000 was subscribed, and with this fund the Morgan Engineering Company, of Memphis, Tennessee, was engaged to devise adequate plans for the protection of the valley, the Conservancy Act of Ohio was framed and pushed through the legislature, and the Miami Conservancy District created, June 1915.

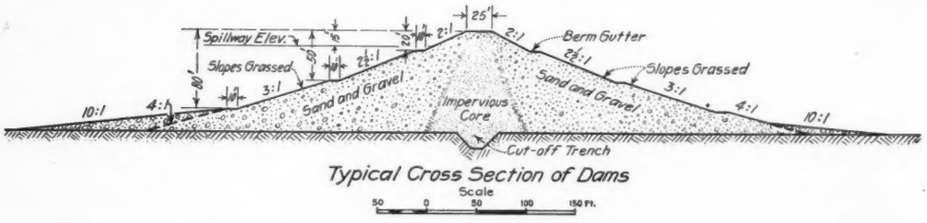
Several years were required to complete the studies and plans and to comply with the many requirements of the courts and the Conservancy Act. Actual construction was begun in the early part of 1918, by force account, after the Directors of the District in vain had tried to let the work by contract.

The plan of protection involves the construction of five large earth dams across the main river and its principal tributaries for the purpose of holding back all flood waters in excess of the carrying capacity of the river channels in the cities. It also involves the betterment of these channels by strengthening or rebuilding the levees, improving the channel cross section and alignment, removing islands and bars, and protecting exposed banks and levees by means of concrete revetment.

The dams stand out as the distinctive features of the project. They are not designed to store water in the sense of ordinary storage reservoirs, for the conduits built through their bases cannot be closed, there being no gates. The ordinary stream flow passes through them unimpeded, and only during high stages, when the conduit capacity becomes too small to accommodate the flood flow, will the excess water back up over the lands above the dams, creating temporary lakes or reservoirs. With the subsidence of a flood the water above the dams will drain out of its own accord and no attempt will be made to store any portion of it. The conduits are so designed that their joint maximum discharge, at no time, will exceed the safe carrying capacity of the channels through the towns.

The foregoing is sometimes spoken of as the "dry reservoir" method of controlling floods. In the Miami Valley the term "retarding basin" has been deemed preferable, being more truly indicative of the impeding or retarding effect produced on the progress of the flood wave.

Normally the lands in the retarding basins are dry and available for cultivation. To the casual traveler through these lands there is nothing to indicate that he is within the confines of a retarding basin, except, perhaps, the absence of houses. The flood season of the Miami is during January, February, and March, hence but little interference with agriculture is likely to take place within the basins. How thoroughly Dayton will be protected becomes plain when it is realized that the four dams located above that city will control the run-off from 2455 of the 2525 square miles of watershed above Dayton. In all, the five dams will control about 2700 of the 4000 square miles of watershed. The combination of retarding basins and channel improvements is designed to provide safety in case of a flood as much as 40 per cent larger than that of March 1913 (the latter was the greatest of which there is record in over a century), although it is



Typical Cross Section of Dams
Scale
50 0 50 100 150 Ft.

"Retaining-levees" in hydraulic-fill dam construction are raised to a height of 10-15 feet, then the enclosed space filled with gravel and other materials conveyed through pipe-lines. When the levees are full, they are again raised and the process repeated. The above illustration shows a typical cross-section of the hydraulic-fill dam.

OUTLET HYDRAULIC JUMP POOL AT TAYLORSVILLE

Showing concrete work in process. A rock excavation of over 60 feet was required at this site. The weir in the foreground is 200 feet long.

LOCKINGTON DAM UNDER CONSTRUCTION BY HYDRAULIC-FILL PROCESS

The concrete outlet structure in the distance is 80 feet high. In the center of the picture can be seen the discharge of gravel and other materials of which the dam is built up.

believed that floods more than 20 per cent greater than the 1913 flood are not possible of occurrence in the Miami Valley because of climatic conditions. The system as designed includes, therefore, an ample margin of safety.

In spite of the war and labor unrest the project has progressed steadily and at the present time it, as a whole, is 50 per cent completed. Two of the dams are two-thirds and the others about one-half completed. One of the major features of the construction work, that of removing railroads and traction lines from within the retarding basins, is now practically accomplished. Channel improvements have been started at all of the towns except two.

The bodies of the dams are of earth and range in height from 65 feet to 110 feet above the valley floors. Their cross sections are unusually massive, as will be noted by reference to the accompanying cut. The cubical contents of the five dams aggregate over 8,000,000 cubic yards of earth, and 170,000 cubic yards of concrete in outlets and spillways. The necessity for building the dams of earth arose from the fact that solid rock foundations were not available at reasonable depths across any of the damsites. It was possible, however, to locate sufficient rock foundation to support, in each instance, the concrete outlet conduits and spillways.

The placing of so large a quantity of earth led to the adoption of the hydraulic fill method, by means of which the materials are sluiced into place, being conveyed mixed with water through large pumps and piping. The principal advantages are: the elimination of man and animal power, resulting in a material reduction of cost; and, second, the sorting of the materials, as they are deposited in place, through a skillful handling of the water. This results in building up a water-tight central core composed exclusively of fine particles, while the coarser materials are deposited in the outer portions of the dam.

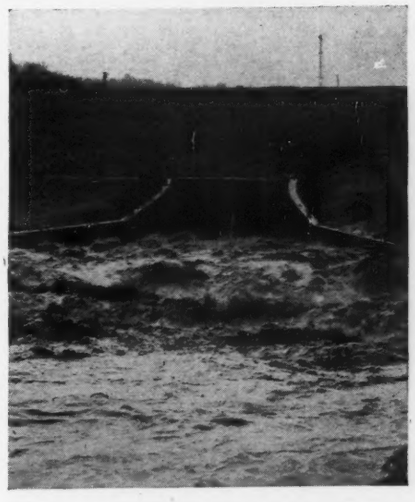
While this method of building dams, known as the "hydraulic-fill" method, has been practised for many years, especially in our Western States, much is being accomplished by the Conservancy engineers towards evolving improved methods. Of particular interest are the tests being conducted to determine the rate of solidification of the impervious core, and the pressures which it exerts within the interior of the structure during the various liquid and semi-liquid stages through which the core passes. On this subject much remains to be learned, and it is expected that the results of these tests will have an important bearing on future hydraulic-fill dam design.

Aside from the hydraulic process described, the work being done by the District is noteworthy for the extent to which man power has been replaced by machinery. Practically all of the larger equipment is electrically driven. The entire construction force of the District numbers only about one thousand men.

Previous to the construction stage the engineering staff of the District made a number of investigations, the results of which have proved of considerable value, not only to the Miami Conservancy District, but to the engineering profession generally. One of these dealt with reducing the velocity of the swiftly out-flowing water at the Conservancy dams. As in some cases the discharge may amount to as much as 50,000 cubic feet per second, traveling with a mean velocity of 50 feet per second, the amount of kinetic energy required to be dissipated, within a relatively short distance, presented no small problem. Experiments made with the aid of models, one-sixteenth the natural size, led to the utilization of the curious phenomenon known to hydraulicians as the "hydraulic jump" as the simplest means for attaining this end.*

Perhaps the most exhaustive study of its kind ever undertaken was that of determining how large a flood was possible of occurrence in the Miami River. This involved a study of 160 great storms that have taken place in the eastern half of the United States, and also a study of long flood records on streams both here and abroad.**

Useful information for hydraulic engineers was derived also from a study of various methods for calculating flow in open channels, including a comparison of velocity formulas.*** Ingenious methods were evolved for computing the effect of retarding basins on floods, and for the proportioning of outlet capacities, heights of dams, and lengths of spillways.****



GERMANTOWN DAM, FLOOD OF APRIL 20, 1920

10,000 cubic feet of water per second are issuing from the outlet conduits. In the background the dam can be seen completed to half its ultimate height.

Editor's Note:

Mr. Arthur S. Morgan has been chief engineer of the District since its inception. Among the many engineers who have been on his staff are the following M. I. T. men, most of whom are still connected with the District: Charles H. Paul, '96, assistant chief engineer; Joseph H. Kimball, '94, constructing engineer; Gerard H. Matthes, '95, engineer; Kenneth C. Grant, '02, assistant engineer; W. P. Watson; G. N. Burrell, '13; and Seth H. Seelye, '12.

The Miami Conservancy District publishes an illustrated monthly Bulletin which describes the progress of the work, and which is regularly received at the Institute Library.

Footnotes

*"Theory of the Hydraulic Jump and Backwater Curves" by S. M. Woodward; and "The Hydraulic Jump as a Means of Dissipating Energy," by R. M. Riegel and J. C. Beebe; Technical Reports, Part III, Miami Conservancy District, Dayton, Ohio, 1917.

**"Storm Rainfall of Eastern United States," by the Engineering Staff of the District; Technical Reports, Parts V, Miami Construction District, Dayton, Ohio, 1917.

***"Calculation of Flow in Open Channels," by I. E. Houk; Technical Reports, Part IV, Miami Conservancy District, Dayton, Ohio, 1918.

****"Hydraulic Problems in Flood Control," by S. M. Woodward; Technical Reports, Part VII, Miami Conservancy District, Dayton, Ohio, 1920.

THE VENTILATION OF VEHICULAR TUNNELS

By A. C. FIELDNER

Supervising Chemist of the Pittsburgh Experiment Station, U. S. Bureau of Mines

The rapidly increasing use of motor vehicles and trucks in the United States is creating an entirely new problem in the proper ventilation of tunnels, subways and other confined spaces through which such machines must pass. This problem has become of immediate importance in view of the fact that a tunnel, 8,000 feet long, is being designed for under the Hudson River between New York City and New Jersey. Another tunnel at Pittsburgh, through the South Hills, 5,700 feet long, is already under construction and a third tunnel, 6,000 feet long, between Boston and East Boston, is being proposed. It is probable that other tunnels will be started in various parts of the United States in the near future.

The ventilation of such tunnels is a serious matter, on account of the poisonous nature of automobile exhaust gases. The poisonous constituent of automobile exhaust gas is carbon monoxide. It is the same gas which has caused the death of so many miners after mine fires and explosions. It is also found in illuminating gas, and here, likewise, has caused the death of many persons.

Carbon monoxide has no color, taste or smell. The smoke that issues from the exhaust of an automobile is not the carbon monoxide, although where there is smoke there is usually carbon monoxide present. The amount of it in automobile exhaust gas varies under different conditions of running a machine. Probably the principal cause for variation is the adjustment of the carburetor. A rich mixture may give as high as 10% carbon monoxide in the exhaust gases; a lean mixture will give an exhaust gas containing less than 1%. There are all graduations between these percentages in practice.

Automobile Road Tests

In order to obtain information on the amount and composition of automobile exhaust gases, the Bureau of Mines has undertaken to make road tests on a number of passenger cars and trucks, in sufficient number to give reliable average figures.

The work on this problem is now in progress at the Pittsburgh Experiment Station of the Bureau. Up to the present time, 40 passenger cars and trucks have been tested. These cars were furnished through the public spirited co-operation of citizens and corporations of Pittsburgh.

All tests are made without any change or adjustment of engine or carburetor, so that the gas analysis obtained represents actual road performance, and not the ideal conditions usually prevailing in factory tests.

Method of Testings

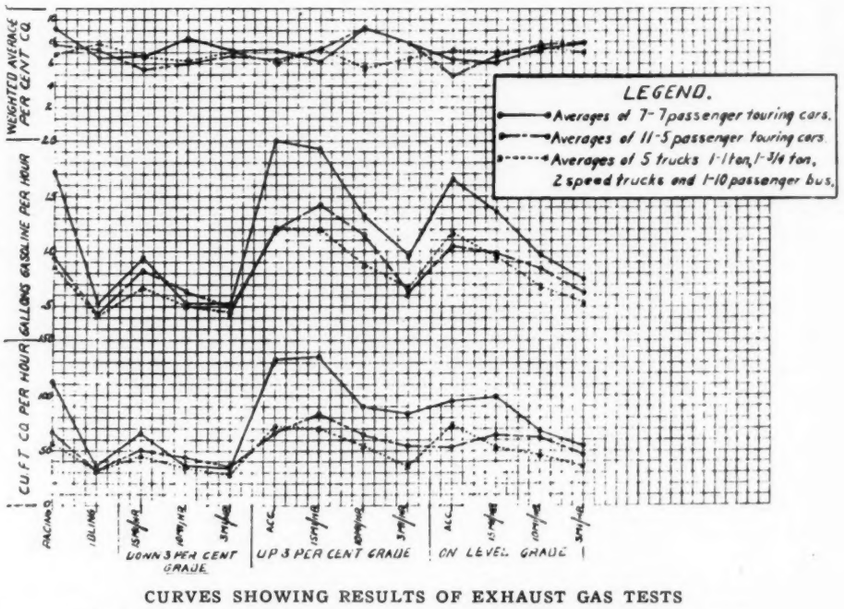
In making the tests, an accurately graduated tube containing the gasoline to be used is attached to the carburetor; another apparatus for collecting the gas sample is connected to the exhaust pipe by means of a copper tube. The car is taken to the test course and run for an exact distance of one mile at the required speed. During this period, the gasoline is accurately measured and a sample of gas is collected. The gas sample is carefully analyzed for all constituents, including CO_2, O_2, CO, H_2, CH_4, and hydrocarbons; and from these results the number of cubic feet of carbon monoxide given off by the car is calculated.

Tests are made on a level grade and up and down a 3% grade, at rates of speed of 6, 10, 15 and 20 miles per hour. Tests are also made with the engine racing, idling, and accelerating, so as to reproduce conditions in a tunnel when it is crowded with cars which are starting up after a blockade in the traffic. Nothing is overlooked in obtaining information which will show the worst possible conditions that might arise in a tunnel.

Effect of Carbon Monoxide

The carbon monoxide in exhaust gases is an active poison, for the reason that it unites with the red coloring matter of the blood and prevents it from taking up oxygen from the air. The victim really suffocates in much the same way as if his air supply were shut off. Only very small percentages of carbon monoxide are needed to render a person unconscious. One per cent in the atmosphere will produce death very quickly. The writer has been in .1% carbon monoxide for one hour, and has suffered a distinct headache from this exposure.

In order to properly calculate the amount of air that is needed to sweep out exhaust gases from a tunnel, engineers must know what is the largest allowable percentage of carbon monoxide that a person may breathe for several hours without any ill effects whatsoever. This problem is also being investigated by the Bureau of Mines. The work is carried on by Dr. Yandell Henderson, Consulting Physiologist of the Bureau, at the Physiological Laboratory of Yale Medical School, New Haven, Connecticut. He is determining just how many parts of carbon monoxide in 10,000 parts of air may be considered safe.


WEIGHTED AVERAGE PER CENT CO
CU FT CO PER HOUR
GALLONS GASOLINE PER HOUR
LEGEND.
Averages of 7-7passenger touring cars.
Averages of 11-5passenger touring cars
Averages of 5 trucks 1-1ton,1-3/4 ton, 2 speed trucks and 1-10passenger bus.
RACING
IDLING
DOWN 3 PER CENT GRADE
UP 3 PER CENT GRADE
ON LEVEL GRADE

CURVES SHOWING RESULTS OF EXHAUST GAS TESTS

Tests were run with twenty-three motor cars and trucks under all possible conditions of road and of engine operation in order to determine the maximum amount of poisonous exhaust liberated per hour by a gasoline engine.

At this present time, authorities differ somewhat in this respect. Practically all of them agree that 1 to 3 parts in 10,000 are perfectly safe for at least an hour. A few authorities believe that even 5 or 6 parts may be safely tolerated. The work being done by the Bureau of Mines should determine which figure shall be used.

Preliminary Results of Tests

From preliminary results of tests on 23 passenger cars and trucks it has been found that the carbon monoxide in the

(*Continued on page* 20)

ASPHALT AND ITS USES

By DR. CLIFFORD RICHARDSON
Consulting Engineer of New York City

Asphalt is a more or less solid form of native bitumen, using the word solid in the ordinary sense in which that term is applied. It originates, in nature, from certain types of petroleum, known on this account as asphaltic. It is the result of the condensation of such oils with the elimination of hydrogen, the latter, in the active state in which it originates, forming water through the reduction of substances with which it comes in contact.

A form of solid native bitumen, gilsonite, which is of commercial importance, is sharply differentiated from asphalt. It owes its origin, as it exists in veins, to a different environment from that under which the formation of asphalt takes place.

Asphalt, of another type, known as artificial or petroleum asphalt, is manufactured industrially by the distillation of asphaltic petroleum, with the removal of its lighter components. It is a residual of a consistency depending on the extent to which the distillation is carried, appropriate to the conditions under which it is to be used.

Asphalt is not a substance consisting of a single individual component but is made up of hydrocarbons of different series, boiling points and solubilities, and of their nitrogen and sulphur derivatives. In the native asphalts, components containing oxygen are present and form a minor but characteristic element of the composition.

Although native asphalt is found in greater or less amount widely scattered over the earth's surface, there are but two deposits of such size as to be of importance from a commercial and industrial point of view. They are known as the Trinidad and Bermudez pitch lakes. The first is in the Island of Trinidad, British West Indies. The other is in Venezuela, separated from the Trinidad deposit only by the Gulf of Paria and distant from it only about sixty miles in an air line.

The two deposits both find their origin in asphaltic petroleum, but the character of the resulting products is quite different owing to the dissimilarity in environment to which the petroleum has been subjected in the two localities.

Trinidad lake asphalt originates in an emulsion of a highly asphaltic petroleum with a paste of extremely fine sand and clay, in a colloidal state, occurring in a mud spring through which the oil breaks out along some line of least resistance. The petroleum is emulsified with this clay paste by the action of the natural gas which accompanies it as the pressure on the latter is released on approaching the surface of the earth. Because of the conditions under which this emulsion is formed a certain equilibrium is established between its components, and the resulting product is of great uniformity from whatever portion of the deposit it is taken over an area of 114 acres and to a depth of 175 feet. In this respect the asphalt is unique and possesses characteristics of the greatest industrial value, which are to be attributed to the great surface energy developed by the mineral matter in the highly subdivided condition in which it exists.

TRINIDAD ASPHALT LAKE

Trinidad Lake covers 114 acres and in some places the depth of the asphalt deposit is more than 200 feet. The lake surface consists of a series of folds, in the hollows of which water usually stands.

Bermudez is distinguished from Trinidad lake asphalt by the fact that it contains only a small and unimportant amount of mineral matter, and that the water with which it is associated is derived principally from rain which falls on the surface of the deposit. The dry material consists of about 95 per cent of bitumen, whereas in the case of Trinidad it reaches but 56. In the construction of asphalt pavements the absence of fine mineral matter of the character found in the Trinidad must be supplied by the addition of similar, but probably, less desirable material, prepared industrially. For many other purposes where the presence of mineral matter is unnecessary or undesirable, Bermudez asphalt plays its own individual role.

Trinidad and Bermudez asphalts, after their removal from the deposits in which they exist, are subjected to a so-called process of refining to prepare them for use in road surfaces and in the industries. This merely amounts to removing the water which they contain with the aid of heat. For paving purposes the material produced in this way is too hard to serve as a satisfactory binding agent for a mineral aggregate. Its consistency is, therefore, softened by the addition of a proper amount of heavy liquid asphaltic petroleum residiuum, the result being known as an asphalt cement.

The petroleum or artificial asphalts depend for their character upon that of the oil in which they originate. As these oils are of the most varied character,

(*Continued on page* 18)

WORKMEN DIGGING AND LOADING ASPHALT

Places from which the native asphalt has been removed fill again, and in a few days all signs of the removal have disappeared. The lake level has only fallen a couple of feet during the time that asphalt has been removed.

THE NATIONAL BUREAU OF STANDARDS

(Continued from page 1)

questions in the field of electricity, and besides is engaged in certain investigations along somewhat analogous lines, such as those concerned with gas service conditions in various cities, various electrical and safety codes, etc.

The division of weights and measures is not alone concerned with the calibration of sets of extremely accurate weights or in the comparison of length standards with those belonging to the Bureau, for it is this division likewise which maintains equipment for testing the railroad track and mine scales throughout the country. It has taken the lead in the development of a process for manufacturing precision gage blocks in this country, and has assisted in the preparation of specifications for all sorts of measuring devices, such as gasoline pumps, volumetric glassware, etc.

Division 3 covers the whole subject of heat and its work goes all the way from the testing of clinical and laboratory thermometers to the scientific investigation of the performance of automobiles, airplane, and other engines.

The optical work, handled by division 4, is of interest to almost every industry. The vital importance of polarimetry in sugar refining and of spectroscopy are well known to all engineering students.

Chemistry, of course, plays an important part in almost all industries and is used by every scientist. Division 5 is, therefore, called upon by every other division of the Bureau for cooperation in connection with certain investigations; it likewise initiates much purely chemical work of its own and carries on a large number of routine chemical tests for other departments of the government.

The sixth division is concerned with such work as aerodynamic physics, the testing of all sorts of engineering instruments, including those used on airplanes, and the standardization of various kinds of mechanical appliances, among which may be mentioned water meters, current meters, fire extinguishers, and similar equipment.

The work of division 7 is of particular interest to engineers and probably is more closely concerned with the industries of the country as a whole than that of any other division. It includes investigations in connection with engineering and structural materials of all kinds, of which may be mentioned, steel, wood, cement and concrete, rubber and leather, textiles, paper, lime, etc.

The activities of division 8 cover the entire field of metallurgy, and its laboratories are equipped for the accurate study of the production and working of metals. Among the equipment may be mentioned a special experimental foundry provided with furnaces suitable for the melting of ferrous and non-ferrous alloys; an experimental rolling mill, easily adjustable for different classes of work; a large forging press; equipment for the metallographic study of test specimens and other up-to-date laboratory equipment.

The ceramics division handles a great deal of work of value to the engineer, since it is concerned with the production of various kinds of refractories, bricks made from various sources, and also with the production of optical glass.

While, as before mentioned, nearly all of the Bureau's work will be found of interest to visitors, it is usually necessary for the average man making a short visit to the Bureau to confine his attention to some few lines of work, of which the following may be taken as typical.

AEROPLANE VIEW OF BUREAU OF STANDARDS

The Bureau is situated in the outskirts of the National capital, at a considerable distance from street cars and other heavy traffic so that the effects of vibrations on the delicate instruments used in standardizing work may be reduced to a minimum.

To the engineer, the work on internal combustion engines, as carried on by division 3, including the testing of airplane engines under conditions of high altitude, will be of intense interest. Likewise, the methods employed in the testing of engineering materials, including a study of the machines which the Bureau uses for this purpose, cannot fail to be of service. The Bureau is the possessor of the largest precision testing machine in the world, a horizontal Emery machine with a capacity of 2,500,000 lbs. in compression and about half that in tension. Its equipment of testing machines of all sorts, including those for cold bend, fatigue, and impact work, is unusually complete. Likewise, the work of the cement section is greatly facilitated by up-to-date and commodious laboratory quarters and by the employment of improved appliances.

The paper section is provided with a complete miniature paper machine on which any grade of paper can be produced in sufficient quantities to determine the commercial practicability of a process, and yet with much greater ease than would be the case in a full-sized plant. The same may be said of the work in rubber, as the Bureau owns a small experimental rubber mill and the necessary testing machines.

The textile section has developed several special machines for testing cloth and its equipment of actual cotton mill machinery is unusually complete.

As before mentioned, the metallurgical division operates one of the few experimental foundries in the world and has for some time past been of considerable assistance to the Bureau's shops in the production of special castings used in connection with the numerous researches continually in progress.

It is probably safe to state that in no institution in the world can such a variety of equipment be found, as in the Bureau of Standards. It is really an industrial plant in which nearly every American industry is represented, and a visit to its laboratories cannot help to have a broadening effect upon any one taking the time to go through them.

Many towns have grown up along railroads and railroads have gone to many towns, but the little city of Osborn, Ohio, enjoys the unique distinction among municipalities of having decided to move to a railroad.

Lying immediately above one of the large dams of the Miami Conservancy Project, Osborn was threatened by submersion in case of flood. The town authorities decided to move the entire community to a new site on higher ground and have selected as suitable, a site which is admirably situated in regard to rail communication. It is about one and one-half miles distant from the former site.

Engineers are investigating means whereby the two hundred and fifty dwellings of the village can be relocated. The unique nature of the undertaking and the speed with which it must be completed, coupled with the fact that steep grades are encountered along the route, have deterred engineering companies from taking up the work.

DR. ELIHU THOMSON

SCIENTIST, INVENTOR AND EDUCATOR

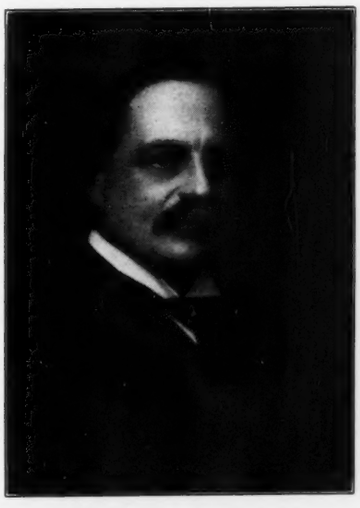
By DUGALD C. JACKSON

Head of the Department of Electrical Engineering, Massachusetts Institute of Technology

Professor Elihu Thomson: If you speak that name in electrical engineering circles, in any part of the world, it at once brings a word of recognition, for Thomson is one of the fathers of electrical engineering as well as a notable leader and master. Though born in England, Professor Thomson came to the United States with his parents when he was five years old and grew up and was educated in Philadelphia. There he graduated from the Central High School with the degree of A. B. at the age of seventeen, and was immediately appointed Assistant Professor of Chemistry in the same school. Six years later he was made Professor of Chemistry and Mechanics. Here he began his researches in electricity and started on his career as an inventor. Fame has been added to the United States and his name spread in technical and scientific circles for the great range and importance of his achievements in electrical engineering.

Interest in electrical phenomena held him for years before his graduation from the Central High School, but it was during his professorship that he started on his revolutionary series of researches and inventions. Here he invented and constructed the famous arc light dynamo with spherical three-coil armature, which went into commercial use in 1880 and continued a central figure in arc lighting service as long as the arc lamp with carbon electrodes held the field of illumination by large lighting units. Here also he made the researches and discoveries which gave the foundation of his later primary inventions in electrical welding. In 1880 Professor Thomson resigned his post in the Central High School and moved to New Britain, Conn., to become the technical head of a company called the American Electric Company which was established on the foundation of his inventions. Three years later this company was reorganized on a larger scale, moved to Lynn, Mass., and was renamed the Thomson-Houston Electric Company. For many years the company occupied what are now called the West Lynn Works, which were gradually increased in size and importance as the variety and extent of the business grew. After the Thomson-Houston Company became associated with the Edison General Electric Company to make the great company known as the General Electric Company, the River Works were built at Lynn, but the West Lynn Works continue to produce many of the important products which the genius of Professor Thomson has conferred on electrical engineering.

To list all of his inventions would be beyond the scope of this article, for more than six hundred patents have been issued to him by the United States. His inventions in dynamo electric machinery, electric welding, electric watt-hour meters, lightning arrestors and magnetic arc extinguishers are fundamental. The arc lamp, the incandescent lamp, the electric motor, the alternator, the alternating current transformer, railway motors, vacuum pumps (for exhausting the bulbs of incandescent lamps), high frequency apparatus, and innumerable other devices of electrical engineering have found improvement at his hands. His touch has ever been of originality and sound scientific conception, so that every part of the art which has passed before him for review has profited from the activity of his illuminating mind.



DOCTOR ELIHU THOMSON

Broad recognition has come to him at home and abroad. Yale University conferred upon him the honorary degree of Master of Arts in 1890, Tufts College the degree of Doctor of Philosophy in 1894, and Harvard University the degree of Doctor of Science in 1909. He was awarded the Grand Prix at the Paris Exposition in 1889 for his electrical discoveries and inventions, and was decorated by the French Republic as Chevalier of the Legion of Honor. Again at the Paris Exposition of 1900 he was awarded the Grand Prix and decorated as Officer of the Legion of Honor. At the Saint Louis Exposition of 1904 he was again awarded the Grand Prize for his electrical achievements. He was president of the American Institute of Electrical Engineers in 1889 and in 1910 was made the first recipient of its famous Edison Medal for meritorious achievement in electricity. In 1916 he received the John Fritz Medal of the four national engineering societies, awarded to him for achievements in electrical invention, electrical engineering, industrial developments and scientific research. Many lesser medals have also been conferred upon him.

His recognition by scientific and professional societies has also been world wide. Having been President of the American Institute of Electrical Engineers in 1889-90, he was United States delegate to the International Electrical Congresses at Chicago in 1893 and St. Louis in 1904, and was President of the Chamber of Delegates and of the Congress at St. Louis. For the three years 1908-11 he was President of the International Electrotechnical Commission which has for its function the important duty of arranging international standardization in electrical engineering, also of providing for the International Electrical Congresses at which units and standards are adopted. Of his numerous scientific and professional societies only his membership in the National Academy of Sciences and honorary membership in the Institution of Electrical Engineers of Great Britain can be mentioned here.

Of great interest to us at the Institute of Technology, is Professor Thomson's wonderful activity in many branches aside from research and invention in the engineering arts, and not the least of these is his constant interest in and support of improved engineering education. For many years he has been one of the most devoted members of the Corporation of the Institute, and a member of its Executive Committee with all the cares and draughts on time and intellect which that exacts. Now in its time of distress over the death of the beloved President Maclaurin, the Institute is fortunate and honored by having Professor Thomson in the post of acting president.

Professor Thomson has been noted for his interest in the careers of younger men, and his assistance and counsel are remembered with affectionate gratefulness by many men who themselves have come to distinguished places in the electrical engineering profession. Men who have had the fortune to serve as his assistants, rejoice in telling of his "many-sidedness" and fertility, for he himself has served them as a University.

THE ARLINGTON STREET SUBWAY STATION

CUT-AND-COVER METHOD OF SUBWAY CONSTRUCTION USED BY THE BOSTON TRANSIT DEPARTMENT AT ARLINGTON STATION

The construction of a station in the Boylston Street Subway near Arlington Street was authorized by the State legislature in 1916, but due partially to the war and to the delay of acceptance by the Boston Elevated Railway Company no construction was started until the fall of 1919. The station is now being built and like many other reconstruction and extension problems, presents some unusual and interesting details. As in subway construction, the station is built by the Boston Transit Department (formerly, The Boston Transit Commission) and rented to the Boston Elevated Railway Company.

The station platforms are 350 feet long which is the length of the present Copley Square and Massachusetts Avenue stations. The width of the platforms is about 13 feet except under the lobby where they are widened out to 26 feet so as to afford room for stairways. As no provision was made in the original subway for a station at this point, some method of underpinning was necessary to support the existing roof on posts instead of the present side walls. A novel form of cantilever beam was developed to support the roof with the minimum interference during construction to the traffic in the subway. A reference to the cross-section shown herewith will indicate clearly the details of the cantilever support. Due to the depth of the subway, approximately a ton per square foot must be taken care of and this necessitated some heavy sections.

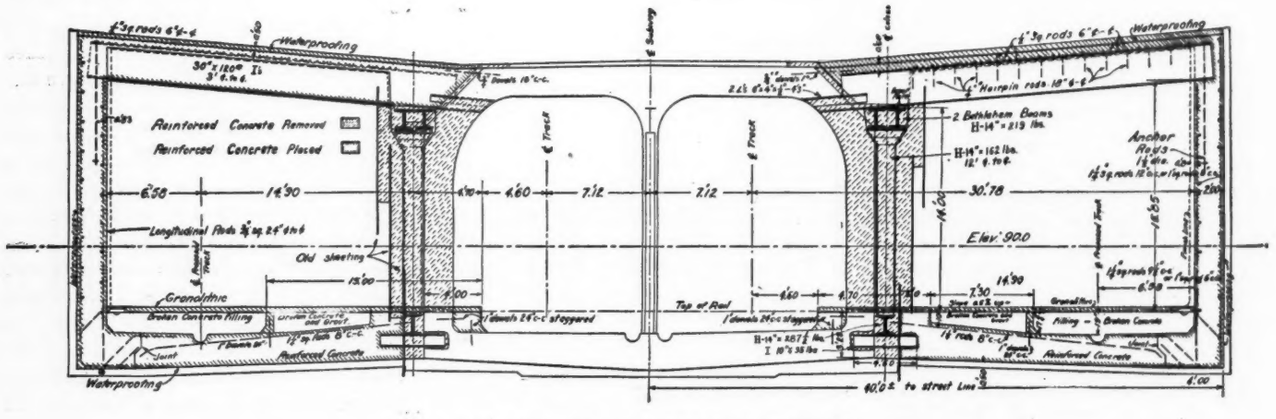
The work is being done by the cut-and-cover method which briefly is described as follows: After taking up the pavement and excavating about 2 feet below street grade, 12" x 12" timbers are placed, spanning from outer street car rail to approximately the building line. A flooring of 4" plank is laid and the excavation carried on with the minimum interference to street traffic. Wood sheeting is driven as the digging progresses and is braced by long struts which also serve to support the various conduits and pipe lines. The excavation requires the removal of 18,000 cu. yds. of earth which is hoisted through small openings and deposited in dump carts.

After excavation to subgrade the reenforcing rods are placed and the invert poured. Approximately 200 tons of reenforcing rods will be placed and 5000 cu. yds. of concrete poured. The steel columns (14" x 162 lbs.) are placed on heavy grillage foundations resting directly outside the old walls and upon 12 foot centers. Upon these columns capped by cast iron plates, rest the heavy longitudinal girders, consisting of two Bethlehem H beams, H14" x 219 lbs. On these beams as a fulcrum, rest the 30" by 120 lbs. cantilever beams placed 3 feet center to center. These are placed on a 1 to 12 slope so as to be able to clear a future outside track and also to pass under the present roof. Because of the clearance limits, only 12" of the depth of the beam could project into the old wall and also have sufficient concrete above to support the roof. Holes are made in the wall and the reenforced projecting ends of the beams inserted in them. The beam is then securely wedged up and grouted in. Anchor rods tie down the farther end so as to take care of the up-lift. The structural steel item alone comprises 700 tons, consisting mainly of I beams and H sections.

After the old wall is relieved of its load, it is cut entirely away. This is a tedious process as it is well reenforced and all of the rods have to be cut by torches. The three foot wall is broken by small "Jack Hammer" air drills. The removal of 2000 cu. yds. of concrete is required. The outside of all new concrete is water-proofed by a preparation of two-ply textile and hot asphalt.

The present subway is sufficiently deep to make possible a lobby above the roof under the intersection of Arlington and Boylston Streets, with entrances at each corner. The Transit Commission has recently been authorized to extend the station and build a similar lobby with entrances and exits at Berkeley Street. This will connect with the platforms by means of a foot passage above the roof. Due to a cross-over, midway between Arlington and Berkeley Streets, the flat type of roof in the original subway was changed to an arch spanning both tracks. Because of the clearance of the cross-over, the subway is wider at this point and will bring the line of columns directly under the walls supporting the arch. This will require the temporary underpinning of the wall before placing the posts and girders. This was avoided in the other sections by the cantilever beams. In order to provide for stairways to reach the platforms a section of the arch will be entirely removed and girders substituted so as to give the required clearance. This extension of the station to Berkeley Street will provide good transit facilities to the rapidly growing vicinity.

The construction is being carried on by the Hugh Nawn Contracting Company under the direction of The Boston Transit Commission. Mr. E. R. Springer is acting chief engineer of the Department and Mr. R. B. Farwell resident engineer in charge.



CROSS-SECTION OF SUBWAY AT STATION

View shows method of supporting roof and waterproofing and draining the station area

THE NEW AEROPLANE

By W. D. RICHARDSON
Of the Curtiss Aeroplane and Motor Corporation

The war was as important in the history of flying as the Renaissance in the history of modern Europe, but aviation has almost forgotten its baptism of fire. There is surprisingly little in the aerial liners and flyabouts of October, 1920 to recall the bombers and scouts of 1917. How did the new types grow? What are their most original and promising features?

CURTISS ORIOLE
Two passenger pleasure aeroplane ready for flight

This is not an attempt to make a scientific or a detailed answer to these questions. It deals only with the general aspects of the change which has occurred in the trend of aeronautical design during the last year and a half. It gives a rough analysis of the forces at work, and shows how they can be traced in certain aeroplanes with which the American public is familiar.

Our Heritage from the War

"The war made aviation," it is commonly said. In one very deep sense this is untrue, for aeroplanes were making tremendous progress in 1914. Of course the war hastened development and made possible the present plane at a much earlier date than could otherwise have been. During the war the aeroplane became an engineering job in every detail, scientific in the quality of every cubic inch of metal or wood or fabric that was subjected to stress. This, of course, laid a basis for commercial design. In addition, the war developed certain aeroplanes suited to certain types of work.

These types, the training, reconnaissance, scout or battle, and bombing planes, were not capable of being put without change to peace uses corresponding to their war services, but they suggested in instances the lines along which peace aircraft could proceed.

War Bequests and Peace Demands

The history of aviation in 1919 and 1920 has been influenced by these types. Engineers had been thinking in terms of them. Factories were adjusted to producing them. There were also many Army and Navy planes to be bought cheaply, and these were adapted.

There was also, however, the demand of the public. It was vague, but it was insistent. The public wanted three things not important in war—passenger capacity, comfort, and economy. These desired ends, joining with the genuine war contribution of certain planes fitted for certain kinds of service have produced the peacetime aeroplane. To date all effort has been centered on three general types of aeroplanes.

There has been, for instance, the tiny "sport" aeroplane, a single seater, represented in America by such types as the Ace, the Pioneer, and the Butterfly. Since especial speed was not desired a lighter and lower powered motor could be used than in a scout, (forty or sixty horse power), and the wing area still be kept remarkably small. To date the success of this general design has not been as pronounced as that of others. It is not economical as a "passenger-mile" affair, and carries no one save the pilot.

Another type, and certainly the most widely used of the new machines, is the two, three, or four passenger flyabout. The two passenger plane approximates the old training machine. The three and four passenger machines are different. The latter have in some instances enclosed the passengers in a limousine interior. The three passenger machines have kept the pilot and passenger compartments open to the air, but have made them practically wind proof, and have secured comfort in flying.

The Curtiss Oriole

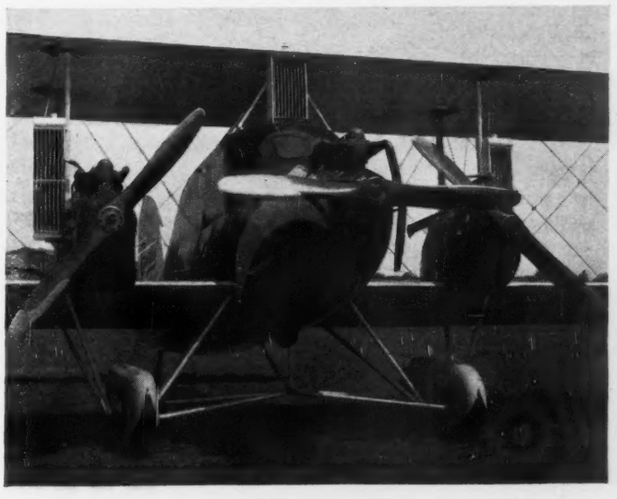
The Curtiss Oriole is a three-passenger aeroplane. It uses a 90 or 150 horsepower motor and attains a speed of 96 miles per hour. Its motor is equipped with a self-starter. The passenger compartment has a side entrance door through which one can step from the wing into the cockpit. The windshield is so designed that the front compartment in which the passengers sit gets little of the rush of air from the propeller. The body is of wood-ply, of torpedo or stream-line shape.

A Ten Passenger Limousine

The Curtiss Eagle represents a great advance in adapting aviation to commercial and pleasure uses. In size and speed it is comparable to the Martin bomber or Lawson passenger carrier. The passenger cabin with its ten seats is not in itself unique, though it is a development following the war. The seats are set two abreast in the interior of the fuselage, the general effect being in part the appearance of a limousine and in part of a Pullman (daytime) interior.

The door entrance in the center of the cabin is reached by a portable flight of steps. The windows are so placed by taking advantage of the curve of the sides that they permit a view upward and downward more easily than the windows of a box-girder fuselaged machine. The

(*Continued on page* 20)



CURTISS EAGLE
View showing the three six-cylinder engines of the Eagle, limousine-body, pleasure aeroplane

The Tech Engineering News

The professional journal of the Alumni and undergraduates of the Massachusetts Institute of Technology. Published monthly at Cambridge, Massachusetts, by the Managing Board of

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CHOOSING A COURSE

Technology offers a great variety of courses for students. They differ just as widely as the students. And the students run all the way from the ex-service man of twenty-five who has seen the value of technical training and knows just what he wants, through the rich man's son whose father wants him to have an M. I. T. degree and doesn't care what he gets it in (and neither does he), to the callow youth from high school who is rather awed by the size of the great court and the erudition of the upper classmen, yes even to the maiden who aspires to express her soul in stone and wood.

Some maintain that the course taken at the Institute is a matter of small consequence, and, for support, point to business men from all courses, electrical engineers from the mechanical department, insurance men from chemical engineering, and it is a fact that graduate electrical engineers (not women) are teaching music, and mechanical engineers practising surgery. It is certainly true that the broad, general training given at the Institute fits one for any of a great number of lines of endeavor. But there is a "nigger in the wood pile."

The thorough training in principles, which Technology gives, insures that anyone of normal ability will ultimately "arrive," no matter what profession he chooses, if he gives himself to it. The speed with which he attains success depends on his particularized knowledge. If he has some knowledge before he enters his life work, he is so much more efficient. If he does not follow out his course, he has more or less wasted the last year of his course and must absorb the knowledge during his work with the consequent handicap of two-years or more. It is for this reason that the course of study should be selected with care, to suit the natural tendencies of the individual and the opportunities which seem to be presented to him.

Dean Burton has very kindly consented to express his opinions on the matter of course selection, in the columns of THE TECH ENGINEERING NEWS and an article by him will appear in the November issue.

TECHNOLOGY'S PRESIDENT

Since losing the builder of the New Technology, the Institute has been marking time. Dr. Maclaurin carried through his plans to a success he could only have hoped for, not really expected. That does not mean, however, that the school has reached the ultimate and cannot be improved upon. It is bound to grow in numbers and influence and advance in methods and curriculum.

No advance can be planned, however, until some one is in the office of presidency to stay. A man who expects or half expects to sever connections with the Institute within a short time cannot plan policies which will extend over a period of decades. It is impossible for the visions of one to be transferred completely to the mind of another. Yet it would be very dangerous to try to select a president without due consideration. Choosing any but the best man for the position would mean not only lack of progress but possibly retrogression. It is a knotty problem which the committee has to face, but let us all hope, for the sake of the Institute and our own sakes, that a worthy successor to Dr. Maclaurin may soon be appointed.

THE EINSTEIN PRIZE ESSAY

No scientific theory since Newton's time has created such a furore among scientific men as Einstein's Theory of Relativity. Through Mr. Higgins' generous gift of $5,000, the Scientific American has taken steps to insure a wider spread of knowledge of the matter. This money will go as a prize to the writer of the best essay, in language understandable to the ordinary man, explaining the now famous proposition.

As has been pointed out by the Scientific American, this prize is substantial enough to attract many. In most cases, it would equal a rather large proportion of the contender's salary, if he has any salary. There will certainly be a very large number of essays entered for the prize.

It will be recalled that when the Republican Party held a contest for the best platform, stating its aims and purposes, a Harvard student won the prize. If a Harvard man can take a national prize on the subject in which he is specializing, Technology students should certainly be able to do as well in their line of endeavor. The Institute courses in physics, mathematics and general sciences are complete enough to enable many undergraduates, among the upperclassmen, at any rate, to write intelligently on Einstein. It would be a great feather in the cap of any student to win such a prize and would add to Technology's growing reputation. We extend hearty encouragement to all Institute men, both students and alumni, who have entered or are to enter this contest.

STUDENT CONTRIBUTIONS

To correct a widely spread misconception, The Tech Engineering News wishes to state that it is very willing to accept student contributions, if they are of such a character as to be suitable for publication. The editors hope to receive a greater quantity of acceptable material from the undergraduates in the future. Their ability to write has been amply demonstrated in the past by the quality of the few which have come in.

THE NOVEMBER ISSUE

The Tech Engineering News takes pleasure in announcing to its readers that the November issue will contain among other features, an Analysis of the Preliminary Returns of the 1920 Census by Roger W. Babson, an article on the Chemical Resources of the United States by Prof. Edward Mueller and an article on Petroleum Engineering by Paul Paine of Tulsa, Oklahoma, who is about to start a series of lectures on the subject of the proposed Course XVI. Another article by Dr. Norbert Wiener on "Modern Tendencies in Mathematics," will be of exceptional interest to engineering students.

CURRENT ARTICLES OF INTEREST

COURSE I

Concrete Tanker Built of Separately Cast Cylinders. A radical design of self-propelled oil carrier. ENGINEERING NEWS RECORD, August 26, pp. 388-393. Room 1-290.

Novel Design Features in Stromberg Motor Devices Building. CONCRETE, August pp. 37-42. Room 1-290.

COURSE II

Ten-Thousand Horsepower Station For Operating Shipyard. POWER, August 24, pp. 284-289.

Toledo Company Building New Plant. THE IRON AGE, August 19, pp. 439-442.

New Coke Plant at Wisconsin Steel Works. THE IRON AGE, August 26, pp. 507-513.

Note:—These are well-illustrated articles on typical modern installations.

COURSE VI

Copper—A Delicate Material. THE ELECTRIC JOURNAL, August, pp. 320-322. Vail Library.

Carbon Brush Testing. ELECTRICAL WORLD, August 21, pp. 368-372. Vail Library.

COURSE VI

Rewinding A Direct-Current Armature. POWER, August 24, pp. 295-297.

COURSE XV

Steps in Installing the Taylor System. pp. 89-96.

The Foreman And His Development. pp. 105-109.

What About The Labor Unions? pp. 109-112. INDUSTRIAL MANAGEMENT, August, Room 1-290.

A GAS CONDUCTOR LAMP

For most purposes the Mazda electric lamp approaches all that is to be desired in electric lighting, yet it has several inherently undesirable qualities in spite of the improvements made upon it by continuous research. The conductor is a rare and expensive metal, the filament is produced by complicated and delicate operations, and its brittle network can not withstand heavy vibrations.

Mr. D. M. Moore has developed, though not yet perfected, a gas conductor lamp in which the current is carried by the gas itself. At present Neon is the most suitable gas to use. Although classed as a "rare" gas it can be obtained cheaply and in quantity from liquid air processes. Among its advantages are high conductivity, high efficiency, and pleasing light. Neon-filled globes can be operated on direct or alternating current with identical efficiency and with a power factor of 85 per cent.

TABLE OF CONTENTS

OCTOBER, 1920

	Page
Problem in Highway Engineering (A. H. Blanchard)	1
A Great Lakes Tidewater Canal (H. C. Gardner)	1
The National Bureau of Standards (H. G. Boutell)	1
The Work of the Miami Conservancy District (G. H. Matthes)	2
The Ventilation of Vehicular Tunnels (A. C. Fieldner)	4
Asphalt and Its Uses—(Dr. Clifford Richardson)	5
Dr. Elihu Thomson—(D. C. Jackson)	7
The Arlington Street Subway Station	8
The New Aeroplane—(W. D. Richardson)	9
Editorials	10
Current Articles of Interest	11
Marine Engineer's Handbook: A Review	11
Alumni Notes	11
A Gas Conductor Lamp	11
Electric Arc Welding	21

ALUMNI NOTES

H. B. Larner, '18, the new Health Officer at Montclair, N. J., has for the past year been health officer for Goldboro, N. C. Following graduation he became a member of the U. S. Public Health Service and for a year was stationed in the South, engaged in rural sanitation studies, epidemiological investigations and other public health work.

Leroy K. Sherman, '92, who recently resigned as President of the U. S. Housing Corporation, has been made Vice-president of the Edmund T. Perkins Engineering Company, Chicago.

George D. Luther, '07, agent for the Electric Storage Battery Company at Denver, has been transferred to represent this company at their Seattle office, 811 White Building.

W. R. Marshall, '90, has been appointed manager of the Industrial Division of the New York City office of the Westinghouse Electric & Manufacturing Company.

Prof. D. C. Jackson, Head of the Department of Electrical Engineering at the Institute, was appointed chairman of the committee on standards by the A. I. E. E. at their recent meeting in New York City.

Water power saved more than 22,000,000 tons of coal in 1919, according to the returns received from about 2800 power plants by the Geological Survey.

A comparison of performance of the motive power of the New Mexico with that of other battleships, shows marked economy in favor of the electric drive. At 12 knots speed, the consumption in tons of oil per day was 75 tons for the New Mexico as compared with 100 tons for the cruising turbines and 118 tons for the main turbines of the Arizona and with 99 tons for the cruising turbines of the Mississippi. At 19 knots, the consumption of the New Mexico was 263 tons, of the Mississippi main turbines, 305 tons, and of the Idaho main turbines, 310 tons per day.

MARINE ENGINEER'S HANDBOOK:—A Review

Divided into fifteen sections and thoroughly indexed for use as a reference and handbook, this publication is the co-operative work of a number of contributors, each a specialist in his own field. Data have been collected from marine manufacturing companies, from large shipyards, and from the Navy Department. As a result, the book represents up-to-date practice, insofar as it has been possible to compile it.

Nearly one-fifth of the entire volume is devoted to the steam turbine. This covers not only the design of the main turbine elements, but lubricating systems, governors, and other auxiliary equipment. Records of tests and trials of marine turbine machinery are illustrated by diagrams and curves of performance. The principal types of marine turbines are described at length, including both those used for propulsion and the smaller auxiliary turbines.

The next largest chapter is devoted to marine boilers. All the types in common use are described, following an introductory historical study of boiler development during the past century. Illustrations and details of design are shown for many types, as well as tables of dimensions and weights of characteristic boilers.

Reciprocating engines are carefully considered, for the reciprocating engine is still much the most numerous of all engines afloat, and it will remain popular for years in freight and other slow service. Elements of design are outlined and details given, with illustrations and tables.

Diesel and other internal combustion engines are treated more briefly, as well as oil fuel burning and other modern adaptations of fuels and power production. Mechanical reduction gears are considered in connection with turbine work, while one chapter is devoted to electric installations. Many pages of details are given of piping, valves and fittings, while one chapter describes methods of measuring the horsepower of marine units, including torsion meters on turbine-driven ships.

Powering and propellers are given two chapters, including an analysis and design of screw propellers based on the work of Admiral Dyson and Admiral Taylor in Washington. Other chapters cover auxiliary machinery, both in the engine room and on deck, including steering gears, winches and other machinery for handling the ship or its cargo.

Frank Ward Sterling, Editor, New York, McGraw-Hill Book Co., Inc., 1920. Pages 1486 plus XVI.

Why good students are not always successful men

IN a certain art school it is said that no medal man has ever become a great artist. But it does not follow that poor students afterward make the biggest men.

Still this is true: Many good students are apt to miss the larger truths. Their very nearness to text book and laboratory obscures their vision of the basic laws which clarify all science and indeed all life.

Studies are of value not so much as exercises in the details of technical lore, but as they help in the search for principles to use later in life.

Perhaps you will forget your calculus formulae and the skilful use of the ruling pen, but the ability to think straight and to co-ordinate thought with action—these are essential to your fullest development.

You may grow to the stature of an engineer who can sell, an engineer who can direct other men, an engineer who can build.

Think about your life that way, and keep this fact before you—

The electrical industry offers a life-work to men who combine vision with constructive common sense.

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Western Electric Company

Western Electric—an organization which through half a century has had a share in bringing the convenience of electric light, power and communication to millions of Americans.

The WORLD'S WORD for ELEVATOR SAFETY

The WORLD'S WORD for ELEVATOR SAFETY

THE KREMLIN, MOSCOW

Most of the famous buildings of the world are equipped with Otis Elevators

THE KREMLIN is the citadel of Moscow. The walls of the triangular enclosure were built in the year that Columbus discovered America. Much of the history of Russia —a dark tale of intrigue, mystery and bloodshed—was enacted in the Kremlin buildings.

The present Great Palace dates back only to Napoleon's day, for his soldiers burned the old palace. There are two Otis Automatic Push Button Elevators in the Great Palace. There is another Otis Elevator in the Nicholas Palace.

This is significant of the world-wide scope of Otis activities. From the first crude hydraulic elevators to the modern miracle of automatic vertical transportation, Otis has led the way and even now is continually developing new and better methods and machinery.

OTIS ELEVATOR COMPANY

Offices in all Principal Cities of the World

AN ALUMINUM TRUCK WHEEL

The Aluminum Castings Company announces a wheel of radical design and construction which is cast in one piece from an aluminum alloy known as Lynite No. 145.

First of all the new wheel reduces tire wear. When a machine strikes a bump, one or more wheels may leave the ground, with the result that the engine immediately races, driving the free wheel at high velocity. When the wheel strikes the ground again it slips due to this increased speed, and causes a grinding wear on the tires. The amount of this slippage is dependent on the time that the motor races, that is, on the time the wheel is off the ground. A reduction of the unsprung weight means less time before the wheel is returned to the road, and thus a smaller velocity increase and less tire wear from grinding. At first this effect may seem to be small, but actual tests show that when one wheel of a truck running at 15 miles per hour hits a two inch bump the wheel is off the ground for 59 inches and then it lands with a severe bump and marked grinding.

The reduction in weight, equal to half the weight of the wheels, can be made up for by allowing a greater load or by reducing the size of the axles, wheels and tires. This means, then, less truck and more load and less gasoline per ton moved.

LYNITE WHEEL
Wheel in use on heavy duty truck

The aluminum wheel is not weak mechanically. In a test a two ton truck had three of its standard wheels replaced by Lynite wheels. Then it was run 500 miles at fifteen miles per hour on a drum dynamometer. The dynamometer drums were each equipped with four strips of half round stock, three quarters of an inch high. At fifteen miles per hour this gave 1320 impacts per mile, or 330 per minute, on each wheel. The strain on the truck was so great that four springs were broken, six bolts sheared off and the chain holding the truck broken. These repairs were made during the test and at the end each wheel had received 6,009,300 impacts. The tire on the steel wheel was then found to be cracked completely across its face and badly worn. The tires on the Lynite wheels were altogether free from cracks and showed much less wear. The wheels themselves showed no cracks, breaks or flaws of any kind, and no visible signs of metal fatigue.

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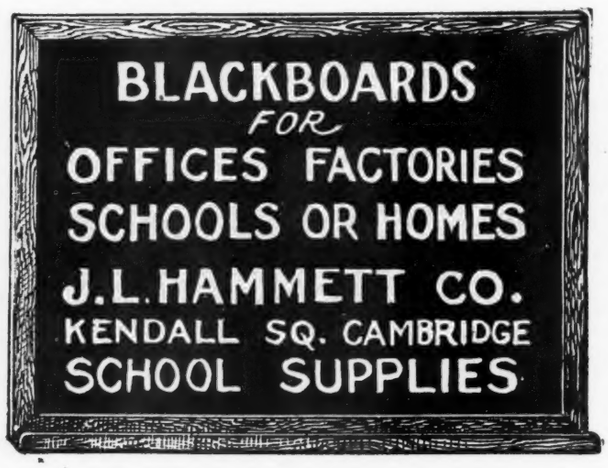


PROBLEM IN HIGHWAY ENGINEERING

(*Continued from page* 1)

Gasoline, 3½ miles per gallon, 14 gallons at 25c.	3.50
Depreciation, 20% on $6,000 investment	4.00
Interest, 6% on $6,000 investment	.60
Insurance, $450 per year	1.50
Garage, rental, etc., $300 per year	1.00
Maintenance, minor repairs, supplies, etc.	1.00
Overhaul, complete overhaul, prorated, 5 cents per mile, or $600 yearly on a fifty mile day	2.00
License	.20
Body upkeep, repairs and painting	.30
Supervision, based on 10% of costs to this point	2.26
Lost time; time lost on repairs, no work, weather or other causes, 20% figured on total, less gas, tires, and oil, etc.	3.70
Total cost per day operated	$28.56

The first classification namely, the unimproved portions of highways, may present conditions of narrow widths of roadways, steep grades, sharp turns or rocky, sandy or clayey surfaces, such that a glance will be sufficient to condemn the route for efficient highway transport. Generally speaking, unimproved highways constitute a positive economic barrier to the development of a highway transport business. It is self evident that poor roads would materially raise the cost of at least the following items on Pride's cost sheet; tires, oil, grease, etc.; gasoline; depreciation; maintenance; and lost time period.

The second classification of highway sections demand serious consideration as construction and reconstruction generally implies that vehicular traffic will be shunted on to detours, most of which are far from satisfactory, considered from the standpoint of economic highway transport.

In connection with the third general class of highway sections of a given route, that is, improved sections which will not be reconstructed in the near future, it is necessary to consider the influence of each fundamental element of a highway upon economic highway transport. The elements which will be considered are drainage, foundations, grades, widths of roadway, shoulders, curves, roadway wearing courses and bridges.

American practice in the construction of drainage systems and foundations is far from satisfactory. The highway transport engineer or manager can neither assume that drainage systems and foundations have been scientifically designed nor that these important elements of a highway have been constructed in accordance with best practice based on service tests. When the transport survey is

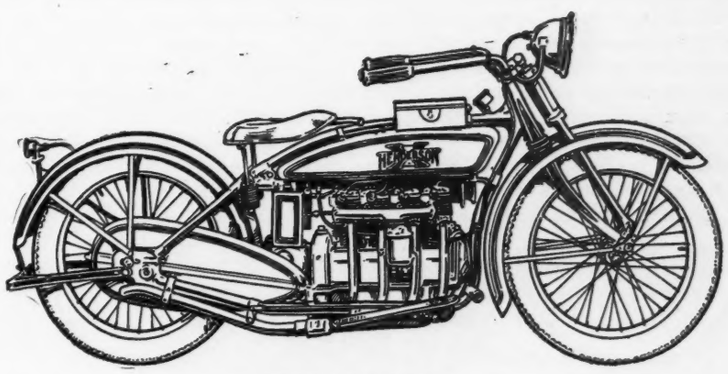
made, care should be taken to determine, by inquiries along the route, the ability of the roadway to carry heavy loads especially during the spring. It is well to keep constantly in mind that an ideal roadway surface is not necessarily an indication that the drainage system and foundation are suitable for motor truck traffic. Poor drainage and weak foundations on a section of a transport route may readily wreck a highway transport business or at least require the charging of higher rates to cover increased cost of operation.

The general deduction may be made that the cost of haulage varies directly with an increase in grade and that the tonnage which can be economically hauled varies inversely with an increase in grade. In all probability the present fundamentals of grade design will not be modified until sufficient data have been accumulated to demonstrate that present practices are uneconomical either from the standpoint of motor transport or the maintenance of the roadway. The cost items relative to tires, grease, oil, gasoline, and lost time period, and probably depreciation and maintenance will be increased by grades on transport routes.

Roadways should be designed to carry the traffic on the paved roadway surface and not rely upon earth shoulders to carry a part of the traffic or to serve as turnouts. On narrow roadways, there will be danger of running onto earth shoulders with resultant serious loss of time if the truck should become stuck in soft material. Furthermore, a given width of roadway is able to carry a certain maximum traffic. As this limiting amount of traffic is approached or exceeded, there will be serious loss of time due to congestion of vehicles. The cost item of lost time, therefore, may be materially increased due to narrow roadways existing on a given transport route.

The development of motor vehicle traffic has resulted in the improvement of the design of highway curves especially in the direction of the easing of sharp curves, provisions for clear sight around curves and the banking of roadways. Many routes, however, have so many sharp turns, that this element of highways may effect economic transport through lost time in negotiating such turns, increased wear of tires, and possible depreciation and maintenance due to collisions or other accidents.

The forces due to motor truck traffic, which should be given consideration in the selection of a roadway wearing course, are the direct loads causing compression on the wearing surface, impact forces, and shearing forces. If all of these forces have not been given proper consideration, the wearing course will wear rapidly or will disintegrate. The wearing course is of particular interest to motor truck users because of the varia-



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tions in resistance to traction on different types of roadway surfaces.

As all types of pavements wear under traffic, the character of the surface of a roadway after two to five years life is generally more important than its condition upon completion of an improvement. Not only is resistance to traffic increased as the surface becomes worn, but, furthermore, the effect on the motor truck through impact forces caused will result in a material advance in depreciation and maintenance charges.

Many highways have had to be abandoned as commercial transportation routes due to the weak conditions of the bridges. One reason for this is that many state laws provide for the construction and maintenance of roadways by the state, while the bridges are under the jurisdiction of towns. Highway transport engineers and managers should thoroughly investigate permissible loads, clearances and roadway widths of highway bridges on transportation routes. Many instances have come to the attention of the writer where bridge load limits of two or three tons have occurred on highways capable of carrying five-ton motor truck traffic.

ASPHALT AND ITS USES

(*Continued from page* 5)

their residuals in the form of asphalt are equally so. They are differentiated, as are the petroleums, by the relative amount of sulphur they contain, and by the presence of small amounts or the entire absence of paraffine scale. These products are brought to a proper consistency to serve as asphalt cements in road and pavement construction and require no fluxing as in the case of the native asphalts.

The native and the artificial asphalts are differentiated most strongly by the fact that the former is the result of natural causes at atmospheric temperatures extending over a long period of time, whereas the latter are produced by industrial processes at high temperatures, not easily regulated, and extending over but a short period.

Asphalt in Highway Construction

Sheet asphalt pavements, of the American type, were first introduced into the United States on any considerable scale, at Washington, D. C. in 1876. Millions of yards of such surfaces have been constructed since that time. They consist of sand of a pre-determined and well recognized grading, which is carefully assembled, of a finely ground mineral matter or filler, such as Portland cement, and of asphalt cement. The mineral matter is known as the mineral aggregate and with it, in a heated condition, is combined the proportion of asphalt which has been determined as suitable for the purpose of binding it together and making it capable of resisting the traffic to which it is exposed.

The advent of the motor car has led to the use of asphalt in the construction of country roads as well as in city pavements. In such case broken stone, or combinations of stone and sand bound together with asphalt, have been employed on a large scale to meet the trying conditions which exist. The result has been entirely successful and large quantities of asphalt are now used for this purpose. Asphalt is also employed for numerous other purposes; on a considerable scale, such as for roofing, damp-proofing, waterproofing tunnels and foundations, for asphalt putty and caulking pitch, for mastic, as a component of paints and varnishes, for pipe joints, and for preparation of a substance known as mineral rubber used in the compounding of rubber goods.

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A GREAT LAKES TIDEWATER CANAL

(*Continued from page* 1)

1. The design and construction of the improvements to permit and facilitate navigation by ocean-going ships.

2. Development of the enormous hydro-electric power.

The St. Lawrence River between its outlet from Lake Ontario and the head of tidewater at Montreal has a fall of 221 ft. The mean flow is 240,000 ft. per second, the minimum and maximum being each approximately 25 per cent of the mean. The question of how to make the improvements and their probable costs is under active study by Col. William P. Wooten of the United States Corps of Engineers and Mr. W. A. Bowden, Engineer for the Canadian Government, who are expected to report this fall. Competent authorities who have studied conditions consider it most likely that they will recommend the construction of a series of great dams to drown out the rapids and create pools. The river has in its course Lake St. Louis, about 14 miles long, and Lake St. Francis, about 24 miles long. These, together with the pools and with Lake Ontario itself, would constitute storage basins sufficient to permit the fluctuation of power production to fit most absolutely the power demand. This is a unique condition not found in any other stream of comparable size.

There is an existing controversy in regard to diversion of water from Lake Michigan at Chicago, involving about 5,000 second feet. If the flow be reckoned at, say, 230,000 second feet, the gross power possibilities on a basis of 100 per cent efficiency are slightly over 5¾ million horse power. If an overall efficiency of 70 per cent be attained, the net distributed power will amount to a little more than 4 million horse power. What the effect of the development of such an amount of power in the St. Lawrence Valley and throughout Northern New York and New England would be is almost beyond definite analysis, but that

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tremendous development would result is undeniable.

The conservation phase of the whole matter is worthy of study. Various figures have been promulgated as to the coal saving equivalent of a horse power year. It should be remembered that the four million horse power above mentioned is net distributed power, and not in any sense peak or gross output. In considering this phase of the matter, it must also be remembered that for each ton of coal used to produce power at local and widely distributed points, there is the incidental coal used in its production and transportation. If we assume that a horse power year would directly save 20 tons of coal, we must then add the coal used at the mine for hoisting, the additional coal used by the locomotive for hauling the coal, and the other small additional amount used by the round houses, repair shops, etc. It seems evident that a gross figure of 25 tons per horse power year could be saved; in other words, 100,000,000 tons of coal per annum would be conserved by the full development and utilization of the power of the St. Lawrence.

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THE VENTILATION OF VEHICULAR TUNNELS

(*Continued from page* 4)

exhaust gas varies from 6 to 8 per cent on the average for various running conditions.

The essential figures for calculating tunnel ventilation are given in the lower graph of "Cubic feet CO per hour". (See graph). This graph is a composite of the other two graphs and obviously its form is decided by the gasoline consumption rather than the exhaust gas analysis. Hence we find that the greatest evolution of carbon monoxide is with maximum power demand as on the upgrade at the maximum speed.

An important conclusion from these tests is that the great majority of passenger cars and trucks are being operated on too rich mixtures. In fact, the average of 24 cars tested showed that 20 to 30% of the heat in the gasoline went out in the form of unburned gases in the exhaust; if the mixtures had been leaner, the owner would have obtained 25% more mileage from a gallon of gasoline.

More care in the adjustment of carburetors to give lean mixtures will save in the aggregate a very material portion of our rapidly failing supply of gasoline.

THE NEW AEROPLANE

(*Continued from page* 9)

pilot has self-starter buttons for his motors, which are either three six-cylinder 150 h. p. or two twelve-cylinder 400 h. p. engines. He has the usual equipment necessary in addition,—tachometer, oil and water gauges, gasoline gauge, altimeter, air speed meter, map frame, compass, etc. The interior of the cabin is lighted, and provision is made in the design for a toilet to the rear of the passenger cabin, while baggage is stowed to the rear of that.

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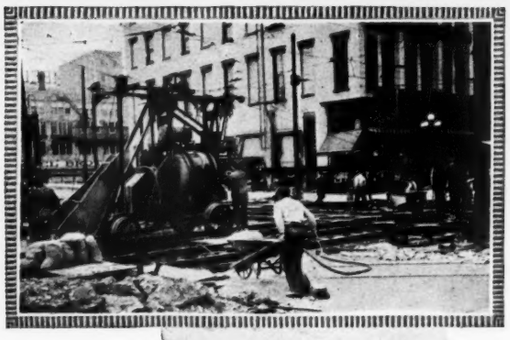

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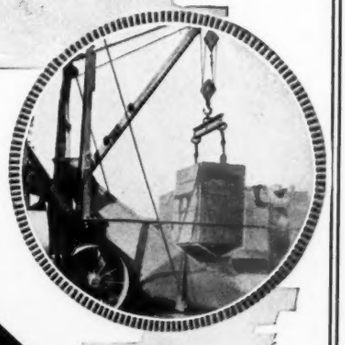

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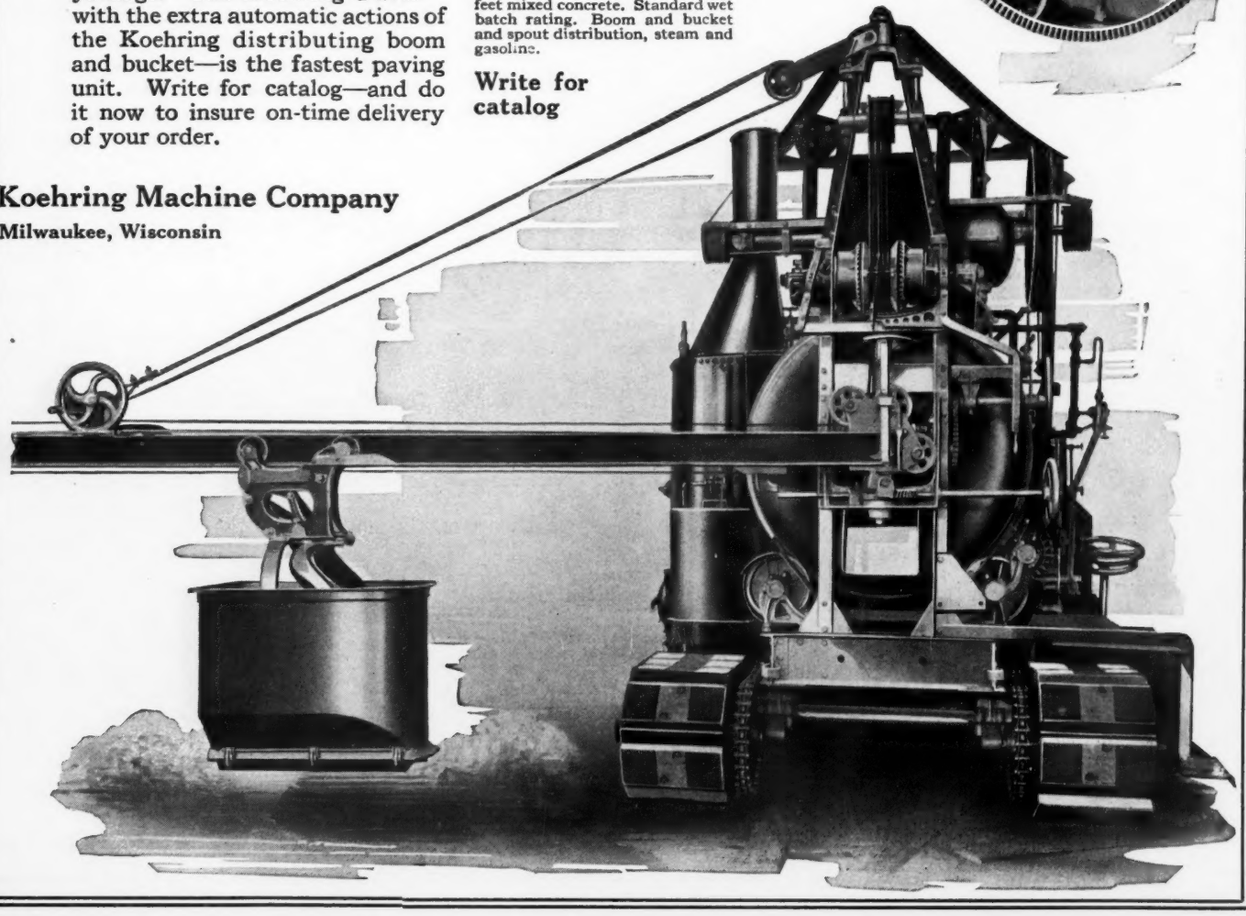

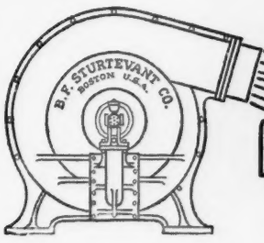

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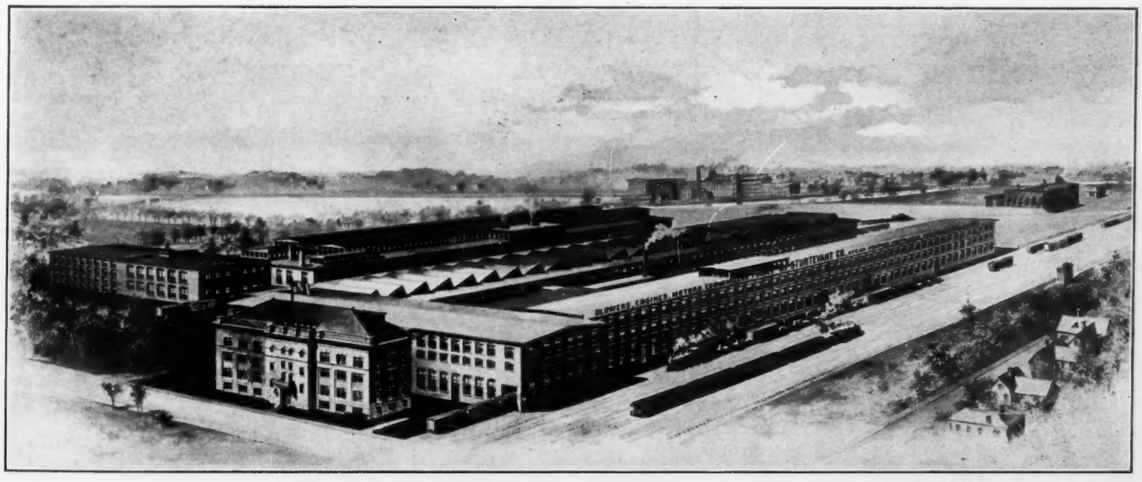

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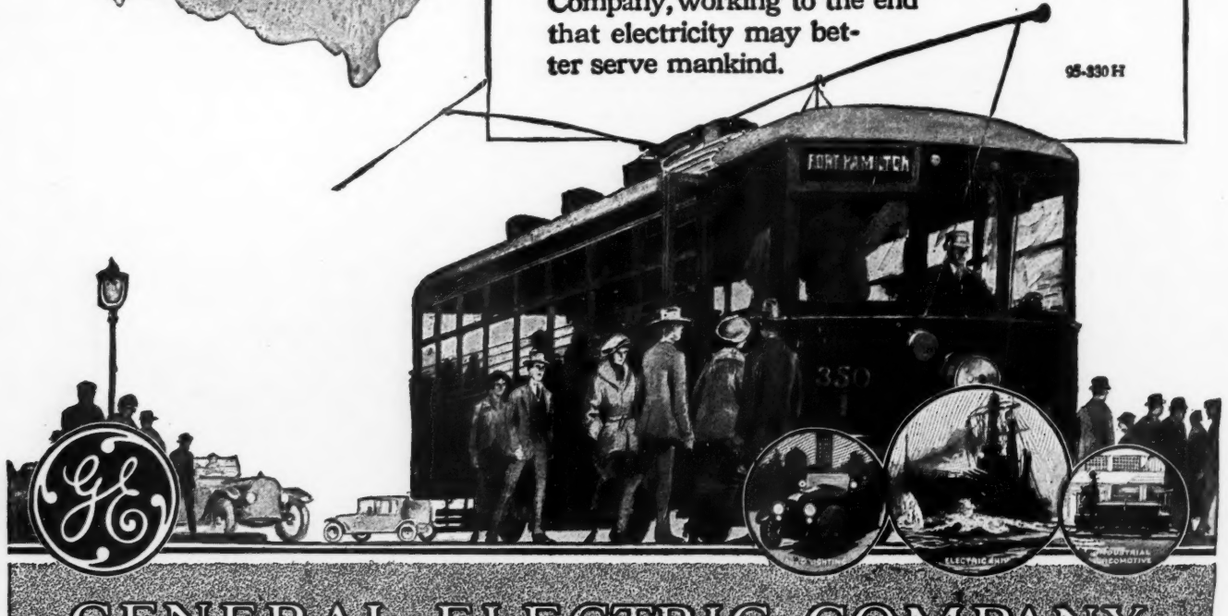

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